

CONSTRUCTION STANDARD SPECIFICATION

SECTION 16741

INTRA-BUILDING TELECOMMUNICATION SYSTEM

FOR PREFABRICATED OFFICE SPACE

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SECTION 16741

INTRA-BUILDING TELECOMMUNICATION SYSTEM

FOR PREFABRICATED OFFICE SPACE

PART 1 - GENERAL

1.01 SUMMARY

- A. Section 16741 covers the products to be used and the specifications for executing intra-building telecommunication cabling both for new construction and remodeling Prefabricated Office Unit projects at Sandia National Laboratories, New Mexico (reference to Sandia hereafter refers to this site). The specification is addressed to any contractor selected to perform such work at Sandia. All work must be performed as described in this specification, on Sandia-supplied drawings, and in the contract documents. In general,
 - 1. The cable system must be installed following manufacturer's instructions and following the design in its entirety as described in Sandia's Statement of Work, on drawings, and in this standard specification.
 - 2. Supply all products, tools, consumables, and test equipment needed to complete the project described in the Statement of Work. Some products may be Sandia-furnished materials (SFM) as noted in the contract documents and on the drawings.
- B. Definitions of Cabling Systems
 - 1. Intra-Building Cable: Telecommunication cable within a building.
 - 2. Inter-Building Cable: Telecommunication cable between buildings.
 - 3. AVAYA Technologies: A company formerly named Lucent that certifies telecommunication personnel and equipment in the United States.
- C. The drawings, which Sandia supplies, delineate the intra-building cable system by locations of intermediate distribution rooms (IDR) Mini IDR, user outlets, rack frame, and cabinet locations. Sandia now supplies only one set of drawings both for RED and BLACK systems.

Raceway and cable routing shown on drawings are not intended to show all support or mounting hardware, or raceway bends, kicks, offsets, and couplings.

- D. Variations: Drawings and other contract documents indicate the basic location, arrangement, and routing of equipment and components. If you wish to make any variations from these specifications based on the site investigation outlined in section 3.01 or for other reasons.
 - 1. Submit a detailed description of proposed improvements and modifications to the SDR for review. Include drawings, manufacturer's literature, and a detailed description of functional improvements.
 - 2. Do not incorporate modifications and associated work until receiving written approval from the SDR.
- E. The project may contain RED [Sandia Classified Network (SCN)], BLACK [Sandia Restricted Network (SRN)], Sandia Open Network (SON), and telephony systems.

RED systems require special security procedures. Contact Sandia's Corporate Computing Help Desk (CCHD) at (505) 845-2243 to request the Protected Transmission System (PTS) Site Manager for information supplementing this specification. All work performed on RED systems must comply with United States Department of Energy (DOE) requirements, which may or may not be explicitly indicated or noted in the contract documents for the project.
- F. Contractor-furnished material and/or SFM may be used as detailed in the Statement of Work and/or elsewhere in contract documents for the project.

1.02 REFERENCES

Following are references that must be used in performing work for Sandia.

- A. Electronics Industry Association/ Telecommunications Industry Association. Commercial Building Telecommunications Cabling Standard [TIA/EIA-568-A-95]. Oct. 1, 1995. (The URL for the association is <http://www.tiaonline.org>)
The TIA/EIA-568-A consists of six publications:
 - 1. Commercial Building Telecommunications Cabling Standard [ANSI/TIA/EIA-568-A-95]
 - 2. Propagation Delay and Delay Skew Specifications for 100 ohm 4-pair Cable [ANSI/TIA/EIA-568-A-1-97]
 - 3. Correction and Additions to TIA/EIA-568-A [ANSI/TIA/EIA-568-A-2-98], Addendum No. 3 to TIA/EIA-568-A [ANSI/TIA/EIA-568-A-3-98].
 - 4. Production Modular Cord NEXT Loss Test method for unshielded Twisted-Pair Cabling [ANSI/TIA/EIA-568-A-99].
 - 5. Transmission Performance Specifications for 4-pair 100 Ohm Category 5e Cabling [ANSI/TIA/EIA-568-A-5-2000].
 - 6. Transmission Performance Specifications for Field Testing of Unshielded Twisted-Pair Cabling Systems [TIA/EIA TSB 67], Oct. 1, 1995.

- B. United States Department of Energy. Telecommunications Security Manual [DOE TSM 200.1-1]. March 15, 1997. (The URL for the department is <http://www.doe.gov>). This manual may not be available to all contractors, but it can be used at Sandia by making an appointment with the Protected Transmission System Site Manager in the Telecommunication Operations Department.

1.03 SUBMITTALS

Submit the following in accordance with conditions of the contract documents and Section 01300, "Descriptive Submittals."

- A. Provide manufacturer's data for specified materials and all equipment not listed in Tables 2 and 3 of this specification.
- B. Provide a list of proposed test equipment you plan to use.
 - 1. Refer to Table 3 for Sandia-preferred test equipment and use the equipment listed.
 - 2. If you choose to substitute test equipment for that listed in Table 3, obtain approval from the SDR by submitting appropriate technical data as specified here. Use of any unapproved equipment may make you liable for retesting all cable terminations at no additional cost to Sandia.
 - 3. Provide a detailed, written description of procedures and equipment specific to testing activities for Sandia's optical fiber (OF) and copper cables.
 - 4. Provide complete technical specifications for OF and copper test equipment if using other than Sandia-preferred equipment listed in Table 3.
 - 5. Provide the software revision number for test equipment using software or firmware.
 - 6. Provide a current copy of the manufacturer's calibration certificate for each piece of test equipment, with traceability to the National Institute of Standards and Testing (NIST) requirements.
- C. Progress Reports on Testing: For all tests performed, submit to the Telecommunication Operations Department paper copies of the Outlet Cable Test Forms within a week of performing the test. Progressive submittals on a weekly basis are required for large-scale tests lasting more than four weeks. Sandia's Telecommunication Operations Department will furnish electronic templates of documentation forms that must be used for test documentation, copies of which are in Appendix B. See 3.08 H for instructions specific to the Outlet Cable Test Form.
- D. Final Reports on Testing: Final reports confirming that cabling has been tested according to Sandia requirements are due to Sandia two weeks after the installation has been completed. Supply to the Telecommunication Operations Department one hard copy of the Outlet Cable Test Forms and all cable charts, and one electronic copy of the final reports for each intermediate distribution room (IDR) and each main distribution room (MDR). The electronic copy must be in IBM-PC format and labeled with the test date, building number, contractor's name, and the contract/job

number. See section 3.08 H for instructions on the Outlet Cable Test Forms and Appendix B for an example test form.

E. Quality Control Documentation

1. Procedures: Before beginning work, provide the following to the SDR:
 - a. Written, detailed procedures including techniques for securing, protecting, and dressing transitions from OF and copper cable to conductor to connector.
 - b. Written, detailed termination procedures for OF and copper conductors.
 - c. A written company quality policy including measures to be taken throughout the contract to ensure delivery of quality work to Sandia.
2. Contractor Qualifications: Before beginning work, provide to the SDR certification of meeting quality assurance requirements and include the following:
 - a. Proof of your status as an AVAYA Technologies Authorized Installer for Sandia; provide an AVAYA Technologies SYSTIMAX 20-year certification for cable terminations and testing.
 - b. AVAYA Technologies training certifications of all on-site personnel.
 - c. AVAYA certification for termination equipment, instrumentation, and supplies.

F. Detailed drawings for new design-build construction projects: These detailed drawings must be submitted and approved by Sandia's Telecommunication Operations Department for all projects before construction begins and must follow Sandia's "Electrical Design Guide Standards", Section 5.

G. As-built drawings: Prepare as-built documentation beginning at the start date of the project. The SDR will provide assistance in obtaining one set of reference drawings. Submit dated as-built drawings to the SDR for review at two-week intervals, beginning at the project start date, or as specified elsewhere in contract documents. One electronic file should be submitted to the Telecommunication Operations Department at the end of the project.

Note: Call attention to changes to the original drawings by circling the affected area in red.

1.04 QUALITY ASSURANCE

- A. Quality must be monitored and quality control must be continuously maintained over manufacturers, suppliers, subcontractors, work force, site conditions, products, and services to ensure all work is of specified quality.

1.05 WARRANTY

- A. A written statement is required guaranteeing performance of the entire installation of twisted pair cable and OF cable for a minimum period of 20 years, starting from the day of acceptance.
- B. If items supplied as part of the project have warranties that will last less than one year after the project's final acceptance, you must supply a warranty for a year after acceptance.

PART 2 – PRODUCTS

2.01 GENERAL

- A. Do not use products that have been removed from existing premises, except as specifically and expressly permitted by contract documents or the SDR.
- B. Use the products specified by standard industry names in Table 2, unless specifically noted otherwise.
- C. Products submitted for approval must be used for the purpose intended. No deviation from products listed in Table 2 will be permitted without prior permission from the Telecommunication Operations Department.

2.02 DELIVERY, STORAGE, AND HANDLING

- A. Provide equipment necessary to handle, transport, and deliver products, including SFM, from storage site to work area.
- B. Store products in original wrappings, and protect from dirt, weather and construction work traffic.
- C. Coordinate with the SDR at least three days in advance to pick up SFM.
- D. Thoroughly inspect products for damage before taking custody, including SFM.
 - 1. Inform the SDR within one workday if SFMs are found to be damaged, and provide documentation with sufficient engineering data to confirm the defect.
 - 2. Replacement SFM materials will be supplied only after defective materials have been returned to the SDR and the defect has been confirmed.
 - 3. If SFMs are rendered unusable and the SDR determines it was because of your error or improper installation, the materials must be replaced at your expense. Return unused SFM with an inventory to the SDR immediately after product use is complete.

2.03 INTRA-BUILDING TELECOMMUNICATION CABLING AND TERMINATION COMPONENTS

A. Copper Cable:

1. Use the cable as specified by manufacturer, pair counts, part numbers, and comcodes in Table 2; substitutes will not be accepted.
2. Supply cable of continuous lengths without splices on reels or in boxes.
3. Follow the color codes shown in Table 1 for termination of conductors in each twisted pair cable.
4. Follow the manufacturer's instructions for storage and installation.

B. Optical Fiber Cable:

1. For both multi-mode and single mode, follow the manufacturer's type, fiber counts, part numbers, and comcodes as specified in Table 2; substitutions will be not accepted.
2. Supply cable on reels of continuous lengths without splices.
3. Follow the manufacturer's instructions for storage and installation.

C. Termination Components:

1. Components are specified in Table 2; substitutes will not be accepted.
2. Follow the manufacturer's instructions for storage and installation.

2.04 LABELS

A. Intra-Building and Inter-Building Cables:

1. All cables must be labeled. For this, use a portable labeling system printer, Brady LS2000 or a system of equal capability approved by the SDR.
2. Missing or unclear nomenclature is not a reason not to identify cables; if nomenclature is a problem, bring it to the SDR's attention.
3. Refer to section 3.06 for details on labeling intra-building cables.

PART 3 - EXECUTION

3.01 SITE INSPECTION REPORTS

- A. Do not begin work until a detailed inspection of the existing site has been performed and a site-investigation report has been submitted to the SDR. Verify the following and include in the report that:

1. The information presented in the contract documents is correct or
 - a. Show proposed modifications and reasons for change, including specification sheets and written functional requirements to support findings.
 - b. Include drawings and other data required to show variations and corrections.
 - c. Indicate the associated costs to accommodate existing site conditions.
- B. If the SDR determines the work schedule will be affected by information presented in site investigation report, the SDR will notify you. You must revise the initial progress schedule and resubmit it to the SDR for review and approval.
- C. When all conflicts between contract documents and site-investigation information have been resolved, certify in writing that the site investigation has been completed and that:
 1. Except for items noted, the conditions shown and described in the contract documents are correct.
 2. Equipment can be installed, and work can be performed as specified without conflicts with existing site conditions.

3.02 TYPICAL OUTLET CONFIGURATION FOR EACH USER LOCATION

- A. Each user outlet must include a minimum of three copper cables and one four fiber Multi-mode fiber. If drawings or other contract documents indicate installation of less than the above minimum capability, you must immediately notify the SDR and the Telecommunication Operations Department.
- B. A single copper cable may be installed only to telephone outlets that are to be wall mounted in hallways to gain access to a restricted area.

3.03 ADDITIONAL ELECTRICAL REQUIREMENTS

- A. Two 20-amp dedicated electrical circuits with 20-amp receptacles must be installed in each communications equipment cabinet. This cabinet is wall mounted. See Table 2 for part numbers
- B. The electrical equipment listed on Standard Drawing T-6001STD must be used without substitutions. Substitutions may only be approved by the SDR.
- C. Standard drawings T-9001STD, T-5002STD, TJ5001STD, T-5003STD, T-5004STD, T-6001STD, T-1001STD AE5032STD and AE3034STD must be adhered to. If standard drawings are not issued as part of the drawing package, you must notify the SDR before construction begins.

3.04 CONDUIT

- A. Maintain a minimum of 2-inch separation between conduits used for RED systems and all other conduits.
- B. Ensure that concealed pathways for vertical conduit drops, such as the drops from the ceiling space to a flush-mounted junction box behind a user outlet, are continuous conduit from inside the junction box within a wall to an accessible location, such as above a lay-in ceiling. This vertical run of conduit, for RED communications must be continuous intermediate metal conduit, terminated with locknut and bushing inside the junction box to which the user outlet is mounted. Consult the Sandia Protected Transmission System (PTS) Site Manager for guidance where conduit cannot be continuous without coupling. Intermediate metal conduit must be inspected by a PTS inspector certified by the Telecommunication Operations Department before the conduit is covered up, for example, by drywall.
- C. RED System Only: Tamper-indicating prismatic seals (TIPS) must be installed by a PTS Inspector certified by the Telecommunication Operations Department on any inaccessible (concealed) conduit couplings and connectors. ONLY connectors and couplings rendered inaccessible and thus, non-inspectable, require these seals. You must install all KNOWN concealed conduit in such a manner as to avoid use of TIPS as much as is practicable. Consult with Sandia's PTS Site Manager for alternate installation methods. These may be used after approval by the SDR. Surface-mounted conduit from the user outlet to above the lay-in-ceiling is desirable if couplings are to be used.
- D. TIPS must be installed on connectors at conduit rough-in, for example, before conduit is made non-inspectable by installation of building finishes. A certified PTS Inspector must be present when drywall is installed if it conceals conduits. In addition, existing TIPS seals may only be removed by a certified PTS inspector.

3.05 CABLE INSTALLATION

- A. Horizontally and Vertically Installed Cable
 - 1. The use of any cable lubricant should be avoided. However with prior approval from the Telecommunication Operations Department, Polywater high performance cable lubricant is the only lubricant that is allowed.
 - 2. Plan cable pulls so that the maximum number of cables required in a conduit are pulled simultaneously.
 - 3. Copper cable pathways for voice and open BLACK data should be either plenum-rated cable or in conduit as identified and shown on the drawings. RED cables shall be routed in conduit and lockable pullboxes.
 - a. Horizontal cable pathways for BLACK copper voice and data cabling may be exposed within the ceiling space. Horizontal cabling bridging any inaccessible area must be installed in conduit or as indicated on the drawings. Wide-base cable support clips approved for such use by a nationally recognized testing laboratory such as UL must support exposed cabling above the ceiling space at intervals of no greater than four feet on center. Exposed cabling must be routed in bundles of no more than 50

cables with runs parallel or perpendicular to walls and structural members. It must also be parallel to intersections of vertical planes and ceilings and must remain as accessible as possible after all building utilities have been installed.

- b. All copper cable must be routed in such a manner as to avoid possible transmission interference or degradation from all EMI sources present within the ceiling spaces, plenums, floors and walls where such cabling is installed. (For example, electrical ballast in light fixtures causes EMI and this can interfere with how the cable performs.) Copper plenum cables must maintain a 2" separation from RED conduits.
 - c. For Mobile Office groups that have more than 40 occupants a Full size IDR must be installed. For all Mobile office buildings with less than 40 occupants a Mini IDR should be used. A Mini IDR for each RED and BLACK must be installed if RED is needed. See Figure 12 for Mini IDR. Mini IDR shall include wall mounted equipment cabinet, wall mounted locking enclosure for copper terminations, and a wall mounted locking enclosure for fiber terminations if needed.
 - d. Individual copper cable lengths must not exceed 90 meters (295 feet) from an IDR termination to a user outlet. If a cable length exceeds this distance, notify the SDR. Do not place any cable at longer distances until directed to do so by the SDR.
 - e. If deviations from drawings are required, the SDR must approve them before the affected cables are placed.
 - f. Do not install more cables in conduit than 30 percent fill unless approved in writing by the SDR. All drawings must indicate conduit fill at the time of design.
 - g. If indirect attachments are used, match the grip diameter and length to the cable diameter and characteristics. Reduce pulling forces to ensure that optical fibers and twisted pair copper conductors are not damaged from forces being transmitted to strength member.
 - h. Do not exceed the maximum pulling tension specified by the cable manufacturer.
 - i. Inspect the cable jacket carefully for defects as the cable is played off the reel.
 - j. Take precautions during installation to prevent the cable from being kinked, crushed, or being mishandled.
4. Cable should not be less than the minimum bend radius of the cable as recommended by the manufacturer. You are responsible for determining the minimum bend radii for cable being placed using the manufacturer's latest information. The following minimum bend radius information is provided only as general guidance:
- a. Short-Term No Load: 10 times outer diameter

- b. During Installation: 20 times outer diameter
 - c. At Rest After Installation: 10 times outer diameter
 - d. Individual Buffered Fibers: 19 mm (0.75 inch)
- 5. Vertical Cable Runs: Use gravity to assist in cable placement.
 - a. Start installation at the top of the run and work toward the bottom of the run.
 - b. Hand pull if possible.
 - c. If machine assistance is required, monitor the pulling tension and do not exceed the manufacturer's specified cable-tension limits.
- B. Service loops for outside plant cable terminated within the building must be a minimum of 6 feet or as shown on drawings.
- C. Installation cable-slack requirements are intended to minimize wasting cable. After the cable has been installed, the slack must be as shown on the drawings. If it is not shown or noted, provide pre-termination cable slack as indicated below:
 - 1. Optical Fiber Cables (before termination)
 - a. User Outlet: Not less than 1.5 meters (5 feet), or more than 2 meters (6.5 feet)
 - b. Lightguide Interconnection Unit (LIU): Not less than 2 meters (6.5 feet), or more than 2.5 meters (8.2 feet).
 - 2. Copper Cables, four-pair (before termination)
 - a. User Outlet: Not less than 1.5 meters (5 feet), or more than 2 meters (6.5 feet)
 - b. IDR Termination Frame or 110 block: All cables must be able to reach furthest frame or block location plus 1 meter (3.2 feet).
 - 3. Copper Cables greater than four-pair (before termination)
 - a. Not less than 5 meters (16.4 feet) beyond designated termination point, or more that 10 meters (32.8 feet).
- D. Cable Placement Within MDR or IDR: Route cables to termination points in the most direct possible path.
 - 1. Cable bundles must be combed, and each cable must run parallel to other cables.
 - 2. After combing and straightening cables, separate cables into bundles according to routing requirements and termination points.
 - 3. Secure cable bundles with the hook-and-loop cable strap material listed in Table 2. Do not use cable ties manufactured from hard polymer material, such as plastic or nylon.

4. Begin to comb, bundle and strap cables within 2 inches (51 mm) of exit from conduit. Apply cable straps to bundles at intervals no greater than 12 inches (305 mm) for the entire length of the vertical and horizontal run.
- E. Splices: Do not use splices in cabling.
1. Splices are not allowed in copper cable. Splices are permitted in other cable types only as a last resort, subject to the following conditions:
 - a. Written approval is obtained from Sandia's Telecommunication Operations Department before the cable is spliced. (Approval is issued only on a case-by-case basis.)
 - b. The location and type of the splice is documented as part of the as-built and record drawings.
 - c. Cable is retested after splicing. If the cable fails the test, notify the SDR of the problem and provide proposed procedures to eliminate the deficiency.
 - d. You correct the deficiency and retest all cables that failed test procedures.
- F. Install rack-mounted and wall-mounted termination panels, horizontal and vertical troughs, and frames as described in contract documents.
- G. Install couplers, buildouts, and their support panels for optical connections at both ends of optical cables and for copper connections at the user outlet.
- H. Install plastic user outlet box, front covers, back panels, and associated user outlet parts. Install copper faceplates.
- I. Cover optical connectors, couplers, and buildouts with clean optical dust caps of the appropriate type.
- J. Install BLACK cabling so that it enters the BLACK IDR or Mini IDR.
- K. Install RED cabling so that it enters a separate RED IDR or Mini IDR.

3.06 LABELING

- A. Intra-Building Cables: For copper and OF cable, label each cable at each end with a unique identifier. See Appendix A, Label and Wiring Details.
1. The floor designation for horizontal cables, and cables to desktop must be the same as the desktop outlet location.
 2. The floor designation for backbone cables, cables from MDR to IDR, and IDR to IDR must be the floor where the cable originates, with the origin point being the MDR.

3. Sandia's Telecommunication Operations Department will provide guidance on the numbering sequence information for cabling projects.
 - a. If any of the characters change, with the exception of last four, then the numeric sequence must start at 0001.
- B. Copper Cable 110 Wiring Blocks: Floor-standing frames with 110-type wiring blocks must be used for a full size IDR, use 110 wiring blocks in locking enclosures for Mini IDR; refer to Table 2 for the product part numbers.
 1. Wire punched down on 110 wiring block must be labeled on 110 wiring blocks as individual pairs.
 2. Label 110 wiring block pair count using an Excel spreadsheet template, together with a color transparent plastic strip (which is SFM) for color-coding. Refer to Appendix A, Label and Wiring Details.
 3. Voice and data 110 wiring block labels must be distinguished by the following abbreviations (see Appendix A, Label and Wiring Details):

Data Frame Example: 8361FADC	Voice Frame Example: 836FAVC
DT = Data Campus Cable	VT = Voice Campus Cable
DM = Data Backbone Cable	VM = Voice Backbone Cable
DL = Data Network Cable	VP = Voice ISDN Power Cable
DU = Data Horizontal Cable	VU = Voice Horizontal Cable

4. Provide floor-standing frames as indicated in Table 2. Groups of blocks are to be designated as campus cables and/or backbone cables, power cables, network cables, and horizontal voice or data cables. See Appendix A, Label and Wiring Details, Figure 2 for layout.
5. Install an engraved label on each floor-standing frame. See Appendix A, Label and Wiring Details, Figure 3, for label specification and sequence of information.
6. All RED data frames must be marked vertically on each side with red/white striped tape or painted red.
- C. Lightguide Interconnection Unit
 1. Attach an engraved label to the door of an LIU. The LIU label must have a building number, IDR number, and numeric sequence. See Appendix A, Label and Wiring Details, Figure 4 for layout.
 2. List cable(s) and room number on the LIU together with the LIU name. See Appendix A, Label and Wiring Details, Figure 5 for layout.

3. Provide a continuous numbering sequence for individual fibers. Number individual fiber strands in LIU from 1 through 24, for cables with 24 fiber strands or fewer. See Appendix A, Label and Wiring Details, Figure 6 for layout.
4. Use multiple LIUs for cables with more than 24 fiber strands, and label sequentially according to number of fiber strands. See Appendix A, Label and Wiring Details, Figure 7.

D. Telecommunication Cabinet: Includes floor-standing and wall-mounted cabinets.

1. Cabinet labels must have the building number, color designation for classification of network, IDR number, and sequential character. See Appendix A, Label and Wiring Details, Figure 8.
2. Label RED (SCN) and BLACK (SRN/SON) cabinets as two separate systems.
3. Center the label at the top of the front door of the cabinet.
4. Sequential characters must start over when any of the other characters change.

E. Lightguide Termination Shelf

1. Label cable designation(s) on the outside door of the termination shelf.
2. A single shelf may hold more than one campus, backbone or horizontal cable. Do not split a single cable between shelves. Start the numbering sequence from 1 within the shelf, and continue to the last fiber strand within that cable for cable larger than four fibers. See Appendix A, Label and Wiring Details, Figure 9 for layout.
3. Label each individual coupler on the coupler plate with an appropriate sequential number for terminating shelves.
4. Each shelf must contain either single-mode or multi-mode RED or BLACK, not both.
5. Install multiple shelves for cables greater than 72 optical fibers. Label sequentially according to the number of optical fibers.
6. Label four-fiber user cables according to the number of couplers in the shelf.

F. Optical Data Telecommunication Outlet: RED (SCN) and BLACK (SRN/SON)

1. Sandia's Telecommunication Operations Department will provide label sticker(s) for RED and BLACK sections of data outlets.
2. Attach the RED and/or BLACK sticker with the preassigned numeric value to the outlet cover for the appropriate outlet. See Appendix A, Label and Wiring Details, Figure 10 for examples of sticker placement.
3. Attach a Brady label to the back of the outlet plates with the same number as used in performing item 2, above. Having the number in two places will help keep the outlet cover matched to the backplate.

4. Attach a warning sticker with point-of-contact information to the outside of the cover of a RED outlet if TIPS are used according to the DOE Telecommunications Security Manual, see section 1.02 D, References.

G. Copper Telecommunication Outlet: Voice/Data (SRN/SON)

1. Sandia's Telecommunication Operations Department will provide label sticker(s) for Voice/Data outlets.
2. Attach the sticker with the preassigned numeric value to the outlet cover for the appropriate outlet. See Appendix A, Label and Wiring Details, Figure 10 for examples of sticker placement.
3. Attach a Brady label to the back of the outlet plates with the same number as used in performing item 2, above. Having the number in two places will help keep the outlet cover matched to the backplate.

H. Backbone Conduit Pullbox: Install the engraved plastic label on the outside cover of the pullbox. See Appendix A, Label and Wiring Details, Figure 11.

I. Conduit: Label conduits with appropriate color-coded tape. Refer to Standard Drawing T-9001STD.

1. Install a tie-wrap label tag on each conduit end point that terminates in an IDR, MDR or is stubbed through the floor, ceiling or wall without a pullbox.
2. Hand-letter the conduit label with permanent black ink in clear block-type letters.
3. Match the label information to the information in the nearest J-Box label to which the conduit leads.

J. Note on inter-building cabling: For twisted-pair copper cables and OF cable, label each cable at each end with a unique identifier—the same as intra-building cables—with the exception that inter-building cable names must not have building numbers associated with them. (See Appendix A, Figure 3 A.)

3.07 TERMINATION OF INTRA-BUILDING TELECOMMUNICATION CABLE

A. Perform a test sample on the number of terminations designated by the SDR before beginning mass cable termination.

1. Terminate both ends of each type of cable installed.
2. Provide terminations and connections in accordance with cable and connector manufacturer's specifications.
3. Test the terminated cables and submit a test report within one week of performing the terminations.
4. Do not proceed with termination of remaining cables until the test results have been reviewed and approved by the SDR.

- B. Optical Fiber Cables: Terminate both ends of the cables. After termination, provide cable slack as shown on the drawings.
 - 1. If not shown, cables must have the following minimum slack after successful termination.
 - a. One meter (3 feet) slack at user outlets.
 - b. One and one-half meters (5 feet) at LIUs and fiber distribution units.
 - 2. Firmly attach aramid yarn-strength members at both ends of the cable to prevent pullback damage.
- C. Copper Cables: Terminate both ends of cables.
 - 1. After termination, provide cables with enough cable slack for clean dress and to prevent stress and sharp bends on cables.
 - 2. Provide extra cable slack for four-pair cables to allow replacement of connectors. Provide cables greater than four-pair with minimum of 3 meters (10 feet) slack after successful termination. Neatly store slack in cable tray, or fasten to wall adjacent to termination location.
 - 3. Install T568A eight-position, modular, four-pair copper connectors at user outlets and wall plates, as listed in Table 2.
 - 4. For copper, terminate four-pair cables in the IDR on 110 blocks as shown in Table 2.
 - 5. Terminate copper cables with preserved wire pair twists as specified in EIA/TIA 568A.
 - 6. Follow the manufacturer's instructions for installation.
- D. Attach eight-position modular connectors and their faceplates at user outlets into the user end of copper cables.

3.08 TESTING INTRA-BUILDING CABLING

- A. The SDR may witness field tests.
- B. Sandia may perform independent testing.
- C. You will incur all costs for retesting and consumables required by unacceptable test results.
- D. Daily Test Equipment Preparation: Properly configure cable test equipment each day before testing and include the following:
 - 1. Verify that the test equipment is still within the manufacturer's calibration warranty period.

2. Verify that the test equipment is set to “auto test” and that proper cable type and associated parameters are selected.
 3. Verify that the test equipment’s selected nominal velocity of propagation matches the cable being tested.
 4. Perform a self-test of test equipment to confirm its proper ability to function.
 5. Connect test equipment to its matched “smart” terminator and perform an auto test to confirm that the test equipment and terminator are functioning properly.
- E. Copper Cable Tests: Use an EIA/TIA TSB-67 Level-2 tester to automatically perform the following tests.

[NOTE: Category 6 test methods are not yet completely defined as of this date. You must nevertheless comply with all EIA/TIA testing requirements. At such time as the category test requirements are accepted as standards, you will be furnished with revised methods and test forms.]

1. Line Mapping (End-to-End Connectivity). Check four-pair wiring for proper wiring configuration, open conductors, shorted conductors, crossed pairs, and reversed pairs.
2. Loop Resistance (DC-Steady State). Connect an ohmmeter across one end of the cable pair with the shorting terminator across the other end of the cable pair.
 - a. Measure steady-state DC resistance and compare it to the cable manufacturer’s standard values.
 - b. Values greater than allowed resistance are considered to have failed, and values smaller than allowed resistance are considered to have passed.
3. Attenuation: Transmit several signals at increasing frequencies across each conductor and then:
 - a. Measure the signal loss in units of decibels (dB).
 - b. Measure test frequencies and permitted dB loss values at each test frequencies.
 - c. Refer to loss values specified in EIA/TIA 568A.
4. Cable Length: Record the cable length from either the length markings on the cable jacket or from hand-held multi-function test equipment incorporating time-domain reflectometer circuitry.
5. Capacitance: Test each twisted pair with a capacitance meter.
 - a. Test the opposite end of the twisted pair for an open circuit.
 - b. Pass test results must yield capacitance within 2 percent of the cable manufacturer’s specification.

6. Near-End Crosstalk: Measure both the outlet and distribution end of the link.
 - a. The worst pair of cable with near-end crosstalk must be measured in dB.
 - b. Test frequencies and permitted worst pair dB crosstalk values at each test frequencies are specified in EIA/TIA 568A for cable (pending).
7. The result of each test is either “pass” or “fail.”
8. Repair or replace and retest failed cables until passing results are achieved.
9. Complete “Test and Chart Forms” to record cable lengths, test data, location, and calculation results; see Appendix B, Cable Test Forms.
- F. Preparing Optical Fiber Test Equipment: Properly adjust OF test equipment before use.
 1. Follow equipment manufacturer’s detailed instruction manual.
 2. Calibrate variable unit adjustments on test equipment to match the cable manufacturer’s cable transmission parameters.
- G. Optical Fiber Cable and Component Test: Use test equipment listed in Table 3, or Sandia-approved equivalent (only the SDR or the Telecommunication Operations Department may give such approval) and perform the following inspection and tests for OF cable. Properly clean the optical connector end faces before connector contact is made for testing or circuit connection.
 1. Optical Fiber Cable Length Measurement: Record cable length (in feet) from either length markings on the cable jacket or from optical time-domain reflectometer (OTDR) measurements on the “Outlet Cable Test Form.”
 2. Optical Fiber Connector Validation Test: Inspect each OF connector assembly with 400X visual inspection.
 - a. Reject the connector assembly if visible imperfection penetrates the fiber core or if the imperfection risks future damage to the core or mating connector’s surface.
 - b. Reject the connector assembly if the connector loss displayed does not meet the manufacturer’s specifications or is not in accordance with 3.07 dB (worst-case test values).
 - c. Reject the connector assembly if the connector reflectance causes a link return to exceed acceptable link return loss.
 - d. Replace or repolish rejected connector assemblies and retest until acceptable measurements are obtained.
 3. Optical Reference Level Measurements
 - a. Connect the optical source to the power meter with 2- to 3-meter jumper cables that have transmission characteristics identical to the optical link being measured.

- b. Record optical power levels in dBm after operational stabilization; primarily after ambient thermal conditions are reached.
 - c. Repeat this procedure during the measurement process to verify the integrity of OF test jumpers and the optical source.
 - d. Record the optical source and power meter serial numbers of units used on each outlet cable test form in the test equipment section.
- 4. Optical Link Attenuation Measurements: Measure optical link attenuation after both ends of the OF have been terminated and mounted into coupler panels.
 - a. Record and measure the link attenuation with an optical source and power meter.
 - b. Connect the source at one end of the optical link and connect the power meter to other end.
 - c. Record the power received in dB for each wavelength.
 - d. Reverse the location of both source and power meter, and repeat the test.
 - e. Calculate the average recorded power levels for each wavelength and record it in dB.
 - f. Complete the "Test and Chart Forms" to record cable lengths, test data, location, and calculation results. See Appendix B, Cable Test Forms.
- 5. Optical Link Return Loss Measurement: Measure and record the optical link return measurement for single-mode optical links.
- H. Progress Reports: Submit one hard copy of the completed "Outlet Cable Test Forms" beginning one week after cable termination work commences and continuing for the duration of the project. Group weekly submittals by the name of the person performing the terminations, with the company name in the miscellaneous note section. Reports are due to Sandia's Telecommunication Operations Department by 4:00 p.m. each Friday.

3.09 ACCEPTANCE

- A. Optical fiber cable acceptance values are derived from approximately seventy percent (mean plus or minus one standard deviation) of component tolerances. Values shown below represent the worst-case acceptability. Typical results should approach the manufacturer's published statistical averages.
- B. Worst-case test values, as shown in Appendix B, Optical Fiber Cable Test Forms, are derived from the following formula:
 - 1. Worst-Case Acceptable Multi-Mode Optical Link Attenuations:
 - a. 2 ST® II connectors plus 300 ft. optical cable

$$= (2 \times 0.55 \text{ dB}) + (0.09 \text{ km} \times 3.4 \text{ dB/km})$$

- $= 1.1 \text{ dB} + 0.31 \text{ dB}$
 - $= 1.41 \text{ dB}$
 - 1.4 dB for 850 nm
 - 1.2 dB for 1300 nm
 - b. 2 LC® connectors plus 300 ft. optical cable
 - $= (2 \times 0.2 \text{ dB}) + (0.09 \text{ km} \times 3.4 \text{ dB/km})$
 - $= 0.4 \text{ dB} + 0.31 \text{ dB}$
 - $= 0.71 \text{ dB}$
 - 0.7 dB for 850 nm
 - 0.5 dB for 1300 nm
- 2. Worst-Case Acceptable Single-Mode Optical Link Attenuations:
 - a. 2 ST® II connectors plus 300 ft. optical cable
 - $= (2 \times 0.55 \text{ dB}) + (0.09 \text{ km} \times 0.4 \text{ dB/km})$
 - $= 1.1 \text{ dB} + 0.04 \text{ dB}$
 - $= 1.14 \text{ dB}$
 - 1.1 dB for both 1310 and 1550 nm
 - b. 2 LC® connectors plus 300 ft. optical cable
 - $= (2 \times 0.2 \text{ dB}) + (0.09 \text{ km} \times 0.4 \text{ dB/km})$
 - $= 0.4 \text{ dB} + 0.04 \text{ dB}$
 - $= 0.44 \text{ dB}$
 - 0.5 dB for both 1310 and 1550 nm
- 3. Worst-Case Acceptable Optical Link Return Loss:
 - a. 2 ST® II connectors plus 300 ft. optical cable
 - $= 40 \text{ dB}$ for both 1310 and 1550 nm
 - b. 2 LC® connectors plus 300 ft. optical cable
 - $= 45 \text{ dB}$ for both 1310 and 1550 nm

TABLE 1

Cable Termination Color Codes

4 PAIR CABLE	25 PAIR CABLE	100 PAIR CABLE			
		BINDER			
		BLUE	ORANGE	GREEN	BROWN
1 WHITE/BLUE	1 WHITE/BLUE	1 WH/BL	26 WH/BL	51 WH/BL	76 WH/BL
2 WHITE/ORANGE	2 WHITE/ORANGE	2 WH/OR	27 WH/OR	52 WH/OR	77 WH/OR
3 WHITE/GREEN	3 WHITE/GREEN	3 WH/GN	28 WH/GN	53 WH/GN	78 WH/GN
4 WHITE/BROWN	4 WHITE/BROWN	4 WH/BN	29 WH/BN	54 WH/BN	79 WH/BN
	5 WHITE/SLATE	5 WH/SL	30 WH/SL	55 WH/SL	80 WH/SL
	6 RED/BLUE	6 R/BL	31 R/BL	56 R/BL	81 R/BL
	7 RED/ORANGE	7 R/OR	32 R/OR	57 R/OR	82 R/OR
	8 RED/GREEN	8 R/GN	33 R/GN	58 R/GN	83 R/GN
	9 RED/BROWN	9 R/BN	34 R/BN	59 R/BN	84 R/BN
	10 RED/SLATE	10 R/SL	35 R/SL	60 R/SL	85 R/SL
	11 BLACK/BLUE	11 BK/BL	36 BK/BL	61 BK/BL	86 BK/BL
	12 BLACK/ORANGE	12 BK/OR	37 BK/OR	62 BK/OR	87 BK/OR
	13 BLACK/GREEN	13 BK/GN	38 BK/GN	63 BK/GN	88 BK/GN
	14 BLACK/BROWN	14 BK/BN	39 BK/BN	64 BK/BN	89 BK/BN
	15 BLACK/SLATE	15 BK/SL	40 BK/SL	65 BK/SL	90 BK/SL
	16 YELLOW/BLUE	16 Y/BL	41 Y/BL	66 Y/BL	91 Y/BL
	17 YELLOW/ORANGE	17 Y/OR	42 Y/OR	67 Y/OR	92 Y/OR
	18 YELLOW/GREEN	18 Y/GN	43 Y/GN	68 Y/GN	93 Y/GN
	19 YELLOW/BROWN	19 Y/BN	44 Y/BN	69 Y/BN	94 Y/BN
	20 YELLOW/SLATE	20 Y/SL	45 Y/SL	70 Y/SL	95 Y/SL
	21 VIOLET/BLUE	21 V/BL	46 V/BL	71 V/BL	96 V/BL
	22 VIOLET/ORANGE	22 V/OR	47 V/OR	72 V/OR	97 V/OR
	23 VIOLET/GREEN	23 V/GN	48 V/GN	73 V/GN	98 V/GN
	24 VIOLET/BROWN	24 V/BN	49 V/BN	74 V/BN	99 V/BN
	25 VIOLET/SLATE	25 V/SL	50 V/SL	75 V/SL	100 V/SL

TABLE 2
Intra-Building Cabling Parts List

Item #	Item Description	AVAYA Part No.	AVAYA Comcode
1	Rack Mount Optical Dist. Panel for MDR	LSTIU-072/7	105 335 871
2	Coupling Panel for LSTIU (for ST connector)	1000ST (pack of 12)	105 428 486
3	Jumper Retainer for LSTIU	JR1A	104 411 277
4	Cable Clamp	CLMP-12A2	106 230 337
5	Wall Mount Optical Termination Panel	200A LIU	105 535 926
6	Coupling Panel for 200A LIU in IDR (for ST connector)	10A	104 141 858
7	Vertical Trough for 200A LIU in IDR	2A8	106 295 520
8	Horizontal Trough for 200A LIU in IDR	2A6	106 497 761
9	MM STII Connector	P2020C-125	105 143 911
10	MM STII Coupler	C2000A-2	104 148 028
11	MM LC Connector	P1000A-Z-125	107 764 292
12	MM LC Fiber Adapter	C1001B-2	108 072 497
13	MM Cable - 4 Fiber, Indoor Riser	LGBC-004D-LRX	106 291 008
14	MM Cable - 12 Fiber, Indoor Riser	LGBC-012D-LRX	106 291 073
15	MM Cable - 24 Fiber, Indoor Riser	LGBC-024A-LRX	106 058 142
16	MM Cable - 48 Fiber, Indoor Riser	LGBC-048A-LRX	107 531 360
17	MM Cable - 72 Fiber, Indoor Riser	LGBC-072A-LRX	107 531 378
18	MM Cable – 24 Fiber, Outdoor 3DNX, HXM	3DNK-024-HXM	106 331 457
19	MM Cable – 48 Fiber, Outdoor 3DNX, HXM	3DNX-048-HXM	106 331 572
20	MM Cable – 72 Fiber, Outdoor, 3DNX, HXM	3DNX-072-HXM	106 331 697
21	SM STII Connector	P3020A-Z-125	106 812 258
22	SM STII Connector (“Fat Fiber” 127 micron)	P3020A-Z-127	106 812 266
23	SM ST Coupler	C3000A-2	105 271 142
24	SM LC Connector	P1101A-Z-125	107 764 300
25	SM LC Fiber Adapter	C1101A-2	108 072 489
26	SM ST Coupler Buildout Block (LIU)	A3002	106 709 140
27	SM ST Coupler Buildout (LIU)	A3070 - 0 dB	106 795 354
28	SM ST Coupler Buildout (LIU)	A3070B - 5 dB	106 795 362
29	SM ST Coupler Buildout (LIU)	A3070D - 10 dB	106 795 370
30	SM ST Coupler Buildout (LIU)	A3070F - 15 dB	106 795 388
31	SM ST Coupler Buildout (LIU)	A3070H - 20 dB	106 795 396
32	SM Cable - 4 Fiber, Indoor Riser	LGBC-004D-SRX	106 291 016
33	SM Cable - 12 Fiber, Indoor Riser	LGBC-012D-SRX	106 291 081
34	SM Cable - 24 Fiber, Indoor Riser	LGBC-024A-SRX	107 508 327
35	SM Cable - 48 Fiber, Indoor Riser	LGBC-048A-SRX	107 531 345
36	SM Cable - 72 Fiber, Indoor Riser	LGBC-072A-SRX	107 531 352
37	SM Cable – 24 Fiber, Outdoor, 4DNX, BXD	4DNX-024-BXD	105 929 384
38	SM Cable – 48 Fiber, Outdoor, 4DNX, BXD	4DNX-048-BXD	105 929 509
39	SM Cable – 72 Fiber, Outdoor, 4DNX, BXD	4DNX-072-BXD	105 929 624

Item #	Item Description	AVAYA Part No.	AVAYA Comcode
40	OptiDuct Liner 1" – 3 cell (AMP)	599028-1	AMP
41	Copper Cable, Cat. 6, 4 pr., Blue, Plenum, 1000 ft. WE-TOTE	2071 004ABL W1000	107 987 794
42	Copper Cable, Cat 5E, 25 pr., Plenum, Blue, 1000 ft. Reel	2061 025ABL R1000	107 871 477
43	Copper Cable, Cat. 5E, Blue Plenum	2061004BBL W 1000	106 946 825
44	Copper Cable, Cat. 5E, Slate Riser	1061004CSL W 1000	106 836 950
45	Copper Cable, Cat. 6, Slate Riser	1071004BSL W 1000	108 122 532
46	Protector Units ("S" self-heal)-Blk for Voice	4C1S (Black)	104 386 545
47	UTP, 300 pair 110 block	110AW2-300	107 059 917
48	Surface Mount User Outlet, AVAYA White multimedia outlet	M40A1-B-262 (Outlet)	107 992 927
49	ST Insert (8-port) - white	M40ST8-B-262	107 239 485
50	LC (RJ-45) Insert (4-port) - white	M40RJ4A-262	108 004 268
51	Blank Insert - white	M40B-262	107 697 989
52	Modular Flush-Mount Faceplate For Voice/Data Copper Outlet - white	M13L-262	108 168 501
53	RJ45 Module, T568A, MGS200 GigaSPEED, Cat. 6	MGS200BH1-262	108 601 873
54	RJ45 Module, T568A MPS 100 Power Sum, Cat. 5	MPS100EI	108 232 2919
55	Velcro "One-Wrap" Cable Ties, 200 yd Spool	One-Wrap (Black)	Velcro 179914
56	Equipment Rack 24", RED, 84 in. H (19 in. rail)	EDP-4900-SL	EDP
57	Equipment Rack 24", BLK, 84 in. H (19 in. rail)	EDP-4900-SL2	EDP
58	Wall Mount Equipment Rack 24", BLK, 36 in. H (19 in. rail)	EDP-WMSD362430B	
59	Wall Mount Equipment Rack 24", RED, 36 in. H (19 in. rail)	EDP-WMSD362430R	EDP

NOTE:

1. If desired parts are not shown on this table, contact Sandia's Telecommunication Operation Department for parts to be used.
2. Some part numbers and comcodes may require vendor cross-referencing to new AVAYA numbers from older AT&T numbers.
3. Outside plant copper cables may now be produced by Cable Systems International (CSI), rather than AVAYA Technologies. Use CSI cable, ANMA filled ALPETH DEPIC (type). Consult Sandia's Telecommunication Operations Department for additional information.
4. Refer to standard drawings for additional components not listed in this table.

TABLE 3

Sandia Preferred Test Equipment

Equipment	Manufacturer	Model	Description
Optical Loss Return Loss Test Set	EXFO	FOT-913-12D-32 or current model • Multi-mode	Dual Wavelength 850/1300 nm LED source with STII® connector and InGaAs detector.
	TTC	462L or current model • Single-mode	Dual Wavelength 1310/1550 nm Cooler LASER with HRL faceplate connector and InGaAs detector.
OTDR	TEKTRONICS	• TFP2 or current model FiberMaster	
		FM8513-Option 24 or current model • Multi-mode	Dual Wavelength 850/1300 nm source with STII® PC connector
		FM1315-Option 34 or current model • Single-mode	Dual Wavelength 1310/1550 nm source with STII® PC connector
Optical Interferometer	Direct Optical Research Co.	Portable or Bench	Portable/bench video microscope with interferometer
	Norland Products Inc.	Portable or Bench	Portable/bench video microscope with interferometer
Copper CAT 6 Cable Tester	FLUKE	DSP-4000	Multi-function tester

NOTE:

1. Copper cable testers must meet EIA/TIA TSB-67 Level 2 requirements (pending). Known equivalents are available from Microtest and Scope Communications, all with latest available software revisions.
2. Optical cable testers must have preferred sources and detectors as listed above. Attenuation must have an accuracy within plus or minus 0.25 dB, and reflectance within plus or minus 0.5 dB. Submit specifications on desired equivalents for review and approval before using them.

APPENDIX A

Obtain the appendix, Label and Wiring Details, from The Telecommunications Department. It is too large to include with this specification.

APPENDIX B

Obtain the appendix, Cable Test Form, from the Telecommunications Department. It is too large to include with this specification

GLOSSARY

ABBREVIATIONS

CCHD:	Corporate Computing Help Desk
CSI:	Cable Systems International
DOE:	United States Department of Energy
EMI:	Electrical magnetic interference
IDR:	Intermediate distribution room
LA:	Link attenuation
LIU:	Lightguide interconnection unit
LRL:	Link return loss
MDR:	Main distribution room
NEC:	National Electrical Code
NFPA:	National Fire Protection Association
NIST:	National Institute of Standards and Testing
NVP:	Nominal velocity of propagation
OF:	Optical fiber
OTDR:	Optical time-domain reflector
PTS:	Protected transmission system
SCN:	Sandia Classified Network
SDR:	Sandia-delegated representative
SFM:	Sandia-furnished material
SON:	Sandia Open Network
SRN:	Sandia Restricted Network
TIPS:	Tamper indicating prismatic seals